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Alessandro Garassino* & David A. T. Harper**

Penaeus hamleti n. sp. and *Penaeus furensis* n. sp. (Crustacea: Decapoda: Penaeidae) from the Stolle Klint Clay (Paleocene) of Fur Island (Denmark)

Abstract - A small sample of macruran decapod crustaceans, from Fur Island (Denmark), was collected from the Stolle Klint Clay, an informal unit at the base of the Ølst Formation, correlated with the upper Paleocene. This study has permitted the description of two new species, *Penaeus hamleti* and *P. furensis*, both belonging to the family Penaeidae Rafinesque, 1815. These are the first descriptions of macruran decapod crustaceans from Denmark, significantly increasing our relatively poor knowledge of macrurans from the European Tertiary. To date, similar material is known only from Italy, Russia, Turkey and India.

Key words: Crustacea, Decapoda, Paleocene, Denmark.

Riassunto - *Penaeus hamleti* n. sp. e *Penaeus furensis* n. sp. (Crustacea: Decapoda: Penaeidae) dell'unità Stolle Klint Clay (Paleocene) nell'Isola di Fur (Danimarca).

Un piccolo campione di crostacei decapodi macruri, rinvenuti nell'Isola di Fur (Danimarca), è stato scoperto nella Stolle Klint Clay, un'unità informale posta alla base della Formazione di Ølst, correlata con il Paleocene superiore. Questo studio ha permesso di descrivere due nuove specie, *Penaeus hamleti* e *P. furensis*, entrambe appartenenti alla famiglia Penaeidae Rafinesque, 1815. Si tratta della prima descrizione di crostacei decapodi macruri rinvenuti in Danimarca, che accresce le scarse conoscenze relative ai macruri del Terziario europeo. Finora, esemplari di macruri sono conosciuti solo in Italia, Russia, Turchia e India.

Parole chiave: Crustacea, Decapoda, Paleocene, Danimarca.

Introduction

Abundant and diverse invertebrate, vertebrate, and plant biotas have been known from the "Mo Clay" of Jutland for many years (Rasmussen, 1968). The fossils are commonly exceptionally preserved, associated with a variety of clays, diatomites, and volcaniclastic ash layers. Two new species of macruran decapod

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*Museo Civico di Storia Naturale, Corso Venezia 55, 20121 Milano, Italy, e-mail: a.garassino@tin.it
**Geologisk Museum, Øster Voldgade 5-7, 1350 København, Denmark, e-mail: dharper@savik.geomus.ku.dk

crustaceans, *Penaeus hamleti* and *P. furensis*, both belonging to the family Penaeidae Rafinesque, 1815, have been recovered from the basal part of the Ølst Formation, the Stolle Klint Clay, on the island of Fur (Fig. 1).

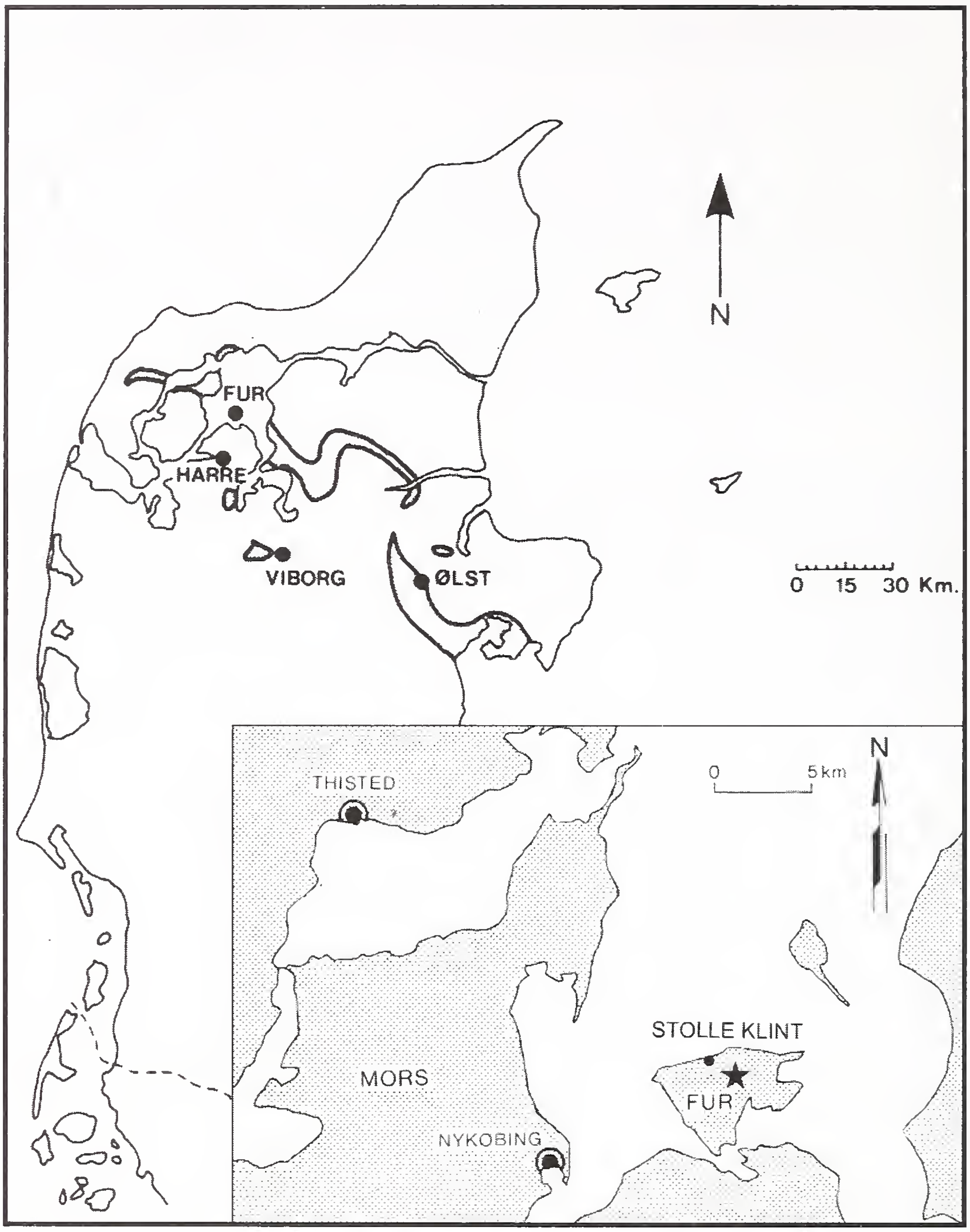

Fig. 1 - Geographical map with the ubication of the fossiliferous locality (★).
Fig. 1 - Mappa geografica con l'ubicazione della località fossilifera (★).

Geographic and geologic setting

During the latest Paleocene, major parts of the North Sea Basin were dominated by the deposition of laminated clays. These strata were laid down under anoxic or dysoxic conditions possibly related to an upwelling system (Bonde, 1974) or a stagnant seabed (Knox & Harland, 1979), both within an enclosed basin system. The Ølst Formation is developed within the lower part of the Paleocene succession on Jutland and is partly laterally equivalent to the Fur Formation (Pedersen &

Surlyk, 1983), a spectacular diatomite deposit characterized by rich insect, plant and bird fossil material (Fig. 2). The formation is fully developed at its type area of Ølst. Farther west and northwest, the formation interdigitates with the Fur Formation and in the Harre Borehole, the Ølst Formation forms a lens within the Fur Formation (Heilmann-Clausen *et al.*, 1984). On the island of Fur, the Ølst Formation forms a thin unit beneath the Fur Formation, represented by the Stolle Klint clay. The Stolle Klint Clay is an informal member (Heilmann-Clausen, 1985), forming the basal part of the Ølst Formation (Heilmann-Clausen *et al.*, 1985). The clay is a laminated unit, up to 15 m thick, restricted in distribution to the Danish Basin. Deposition occurred in a stagnant basin under dysoxic conditions probably in relatively deep water.

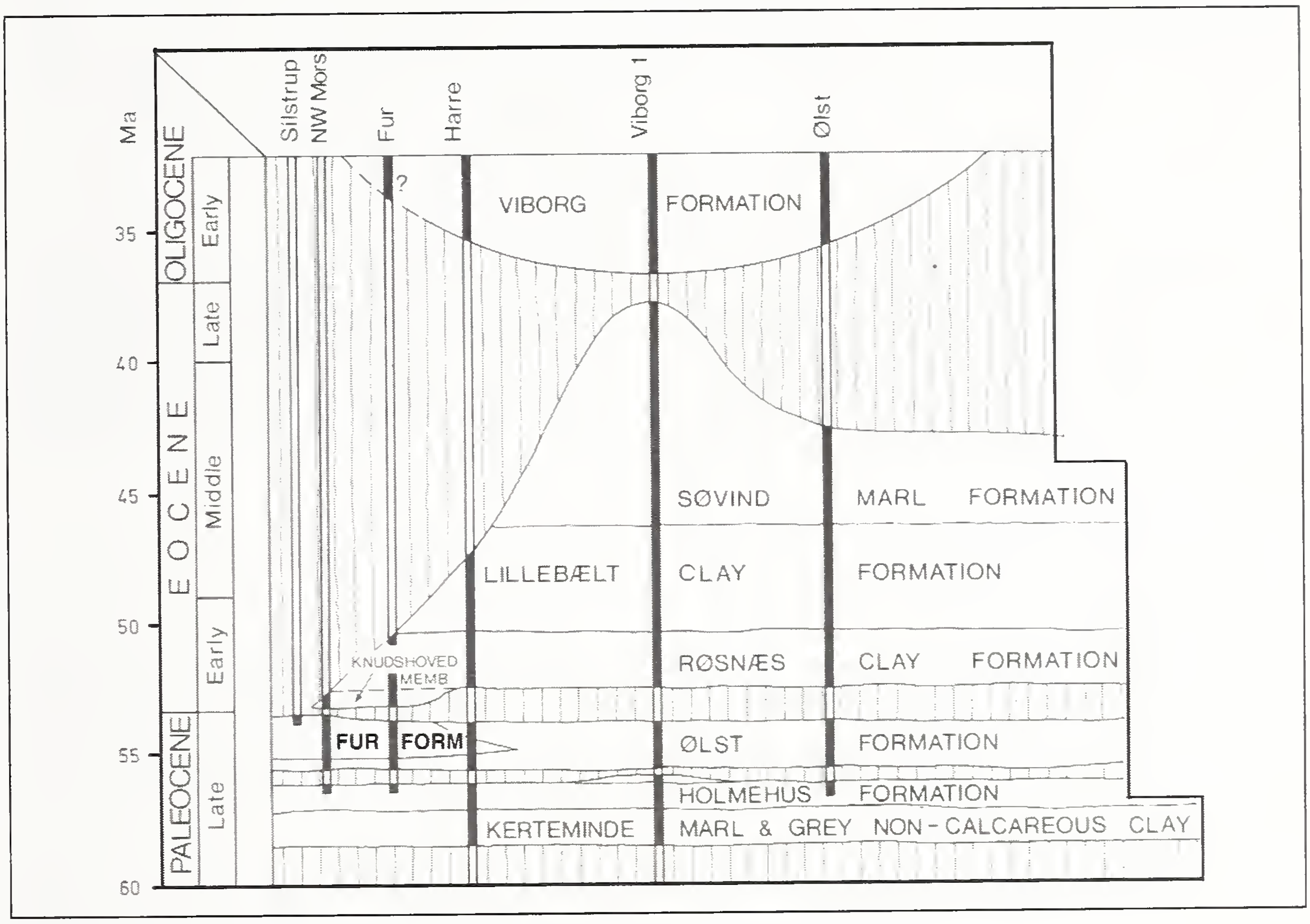

Fig. 2 - Stratigraphic succession with the Fur Formation.
Fig. 2 - Successione stratigrafica con la Fur Formation.

Materials

The studied specimens are well preserved and flattened parallel to bedding. Preparation is relatively easy due to the soft consistency of the surrounding rock. The study of this sample (eleven specimens) allowed identification of two new species, *Penaeus hamleti* (9 specimens) and *P. furensis* (2 specimens), both belonging to the family Penaeidae Rafinesque, 1815. Three further specimens are indeterminate because of their poor state of preservation.

The primary type and figured material is housed in the Geological Museum, University of Copenhagen (prefix MGUH), while one specimen (prefix N) is housed in the Fur Museum and three further studied specimens are in private collections.

Systematic Palaeontology

Infraorder Peneidea De Haan, 1849
Family Penaeidae Rafinesque, 1815
Genus *Penaeus* Fabricius, 1798

Type-species: *Penaeus monodon* Fabricius, 1798

Discussion. *Penaeus* Fabricius, 1798, is known in the fossil record with 20 species. The new and well-preserved species from the Paleocene of Denmark are particularly significant in view of the sparce number of occurrences in the Tertiary. *Penaeus hamleti* n. sp. and *P. furensis* n. sp. are distinguished essentially for the different shape of rostrum. In fact, the rostrum is short with three or four suprarostral teeth in the first species, while it has seven suprarostral teeth and two subrostral teeth in the second.

Penaeus hamleti n. sp.
Fig. 3

Diagnosis: subrectangular carapace; short rostrum with three or four suprarostral teeth; weak cervical and hepatic grooves; weak antennal and cervical spines; pereiopods I-III chelate.

Etymology: the trivial name alludes to Hamlet, Danish Prince and main character of the Shakespearean tragedy of the same name.

Holotype: MGUH 27136.

Paratypes: MGUH 27137, 27138.

Type locality: Stolle Klint (Fur Island, Denmark).

Geological age: Late Paleocene.

Occurrence and measurements: nine specimens in lateral view are ascribed to this new species: MGUH 27136, 27137, 27138, 27139, 27140, and N1244 together with 16-3240 and 16-4364 (Henrik Madsen collection) and 97008 (Søren Kristensen collection). The specimens range in length between 1.5 and 4 cm.

Description. Small-sized penaeid with smooth exoskeleton.

Carapace. Subrectangular carapace with straight dorsal margin. Posterior margin bearing a weak marginal carina. Short rostrum with three to four small suprarostral teeth directed forwards. Weak cervical and hepatic grooves in the anterior part of the carapace. Weak antennal and cervical spines. Large and deep ocular incision. Weak antennal and pterigostomial angles.

Abdomen. Subrectangular somites I-V of equal length with rounded ventral margins. Subrectangular somite VI longer than the previous somites. Straight posterior margins of somites I-III. Posterior margins of somites IV-V turned backwards. Triangular telson with pointed distal extremity. Subrectangular protopodite. Endopodite and exopodite poorly preserved.

Cephalic appendages. Eye with a short eye-stalk. 3rd maxilliped and antennulae not preserved. Elongate triangular scaphocerite with pointed distal extremity.

Thoracic appendages. Thin and elongate pereiopod I-III with small chelae. Pereiopods IV-V not preserved.

Abdominal appendages. Pleopods with an unsegmented peduncle which bears two elongate multiarticulate flagella.

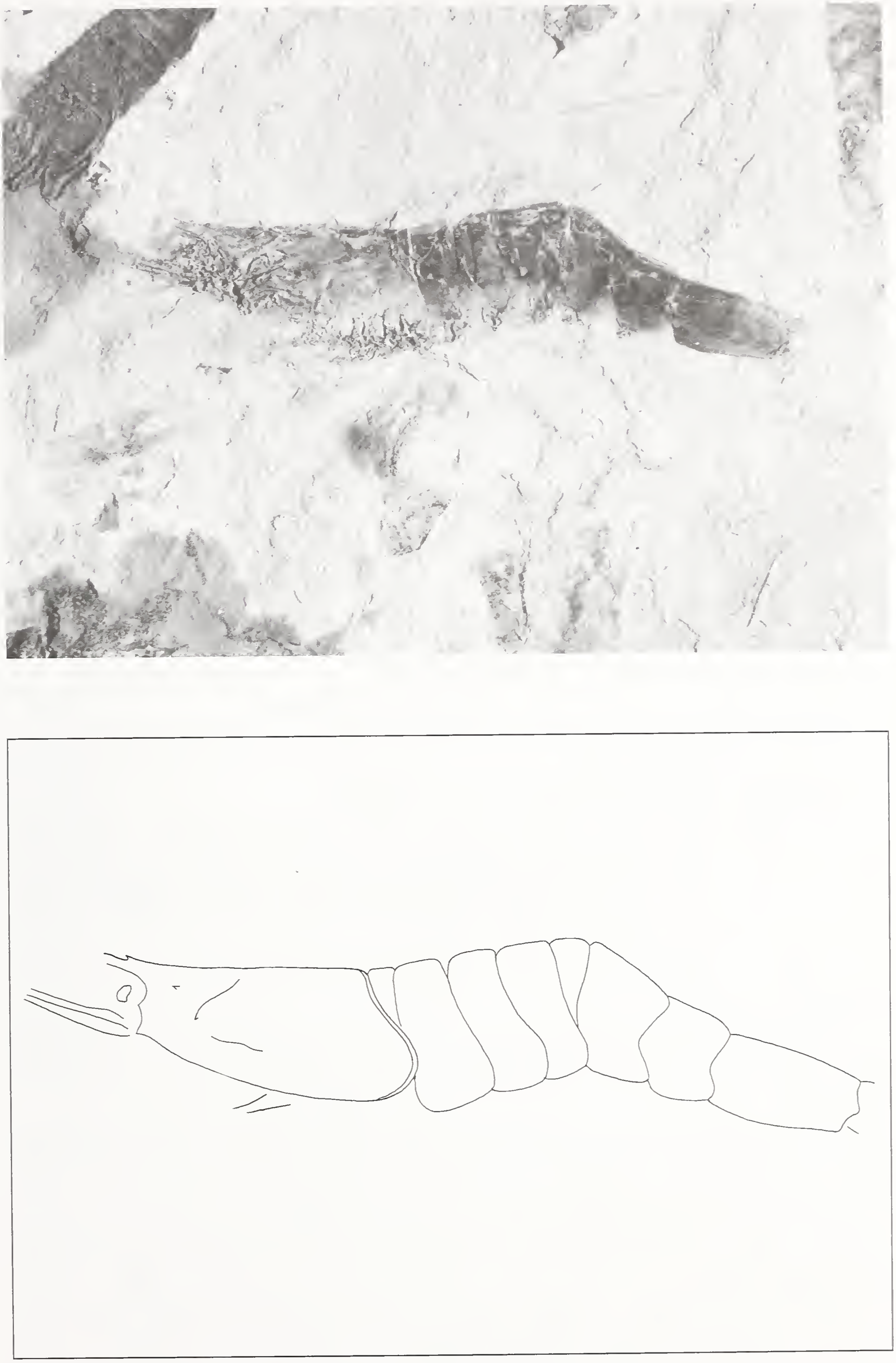

Fig. 3 - *Penaeus hamleti* n. sp., holotype, n. cat. MGUH 27136 (x 2.5).
Fig. 3 - *Penaeus hamleti* n. sp., olotipo, n. cat. MGUH 27136 (x 2,5).

Penaeus furensis n. sp.

Fig. 4

Diagnosis: subrectangular carapace; long rostrum with seven suprarostral teeth and two subrostral teeth; pereiopods I-III chelate.

Etymology: the trivial name alludes to Fur Island where the studied specimens were discovered.

Holotype: MGUH 27142.

Paratype: MGUH 27141.

Type locality: Stolle Klint (Fur Island, Denmark).

Geological age: Late Paleocene.

Occurrence and measurements: two specimens in lateral view are ascribed to this new species (MGUH 27141, 27142). The specimens range in length between 1.5 and 2 cm.

Description. Subrectangular carapace with curved dorsal margin. Posterior margin with a weak marginal carina. Long rostrum with seven small suprarostral teeth and two subrostral teeth directed forwards. Large and deep ocular incision. Weak antennal and pterigostomial angles.

Abdomen. Subrectangular somites I-V of equal length with rounded ventral margins. Subrectangular somite VI longer than the previous somites. Straight posterior margins of somites I-III. Posterior margins of somites IV-V turned backwards. Triangular telson with pointed distal extremity.

Cephalic appendages. Eye, 3rd maxilliped and antennulae not preserved. Elongate triangular scaphocerite with pointed distal extremity.

Thoracic appendages. Thin and elongate pereiopod I with small chelae. Pereiopods IV-V not preserved.

Abdominal appendages. Pleopods not preserved.

Discussion. According to Pérez Farfante (1969), *Penaeus* Fabricius, 1798, dates from the Lower Cretaceous (upper Hauterivian-lower Barremian), and has the following diagnostic characters: rostrum with supra-subrostral teeth, cervical, orbito-antennal and hepatic grooves, strong antennal and hepatic spines and telson with a deep median groove. Some of these diagnostic characters of *Penaeus* have been identified in the studied specimens from Denmark and they are accordingly included within this genus.

Penaeus is currently known only from the Tertiary of Europe and India, with three species from the Paleocene, three from the Eocene and two from the Oligocene.

Prasad (1961) described *P. kapurdii* from the Paleocene of the Rajasthan Region (India) whereas, later, Tiwari (1963) described two other species of penaeids, *P. barmerensis* and *P. glaessneri*, from the same region.

Van Straelen (1940) described *P. smyrnacus* from the Eocene strata of Anatolia (Turkey), whereas Secretan (1975) described *P. bolcensis* and *P. obtusus* from Monte Bolca (Italy).

Garassino & Beschin (1999) reported *P. vanzii* and *P. sorbinii* from the Oligocene of Valle del Ponte and Salcedo (Vicenza, N Italy).

Penaeus kapurdii, having a short rostrum bearing four-six suprarostral teeth, differs from *P. hamleti* which bears a short rostrum with three-four suprarostral

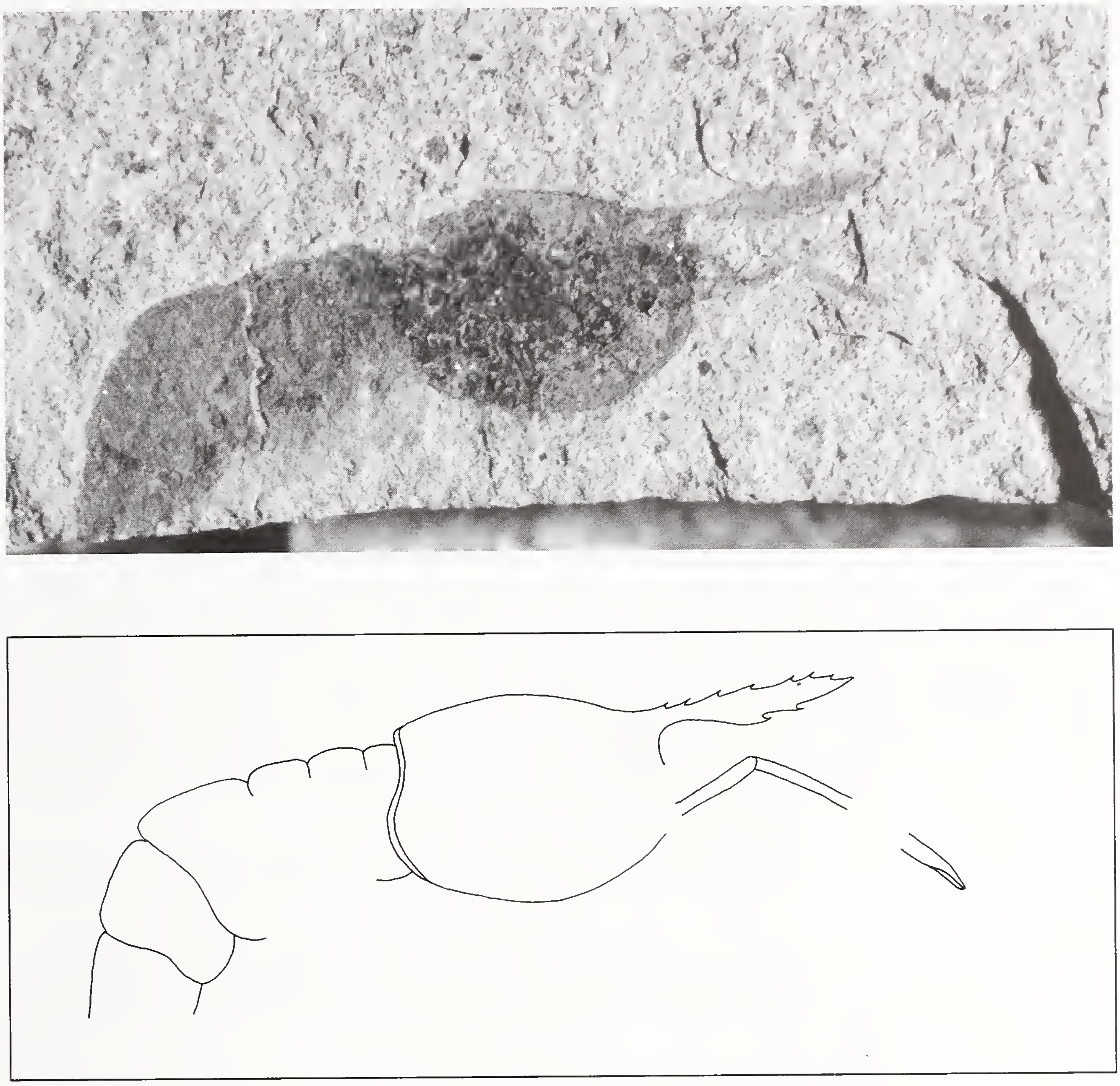

Fig. 4 - *Penaeus furensis* n. sp., holotype, n. cat. MGUH 27142 (x 5).
Fig. 4 - *Penaeus furensis* n. sp., olotipo, n. cat. MGUH 27142 (x 5).

teeth and from *P. furensis* which exhibits a long rostrum with seven suprarostral teeth and two subrostral teeth. The short rostrum with seven suprarostral teeth of *P. barmerensis* distinguishes this species from both *P. hamleti* and *P. furensis*.

The poor state of preservation of the specimens belonging to *P. glaessneri* makes difficult to compare it with the Danish species. Nevertheless, the rostrum mutually distinguishes the three species: the short rostrum with eight suprarostral teeth of *P. glaessneri* is different respect to those of *P. hamleti* and *P. furensis*.

The long rostrum with seven suprarostral teeth and four-five subrostral teeth of *P. bolcensis* is different from those of the Danish species. A comparison with *P. obtusus* and *P. smyrnacus* was not possible because of the poor state of preservation of the Italian and Turkish species. *Penaeus vanzii*, characterized by a long rostrum bearing five suprarostral teeth and *P. sorbinii* with a long rostrum with six suprarostral teeth and two subrostral teeth, both differ from the new species.

The new and well-preserved species described here from Denmark are particularly significant in view of the scarce number of occurrences of the group elsewhere in the Tertiary. They provide an important link with the better-known and important penaeid assemblages described from the Mesozoic.

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